Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

UTILITY USAGE IN SMALL SLAUGHTER PLANTS

ARS-S-174
March 1978

AGRICULTURAL RESEARCH SERVICE • U.S. DEPARTMENT OF AGRICULTURE

CONTENTS

	Page
Acknowledgments	iv
Abstract	1
Introduction	1
Water usage	4
Measurement of water used	4
Water used during livestock slaughter	5
Water used during plant cleanup	7
Analysis of water usage	9
Waste management	9
Energy usage	10
Summary and conclusions	13

ILLUSTRATIONS

Fig.		
1.	Highest, lowest, and average hourly water usage for 5 days at plant 2	4
2.	Cleaning an inedible-offal container with a high-pressure washer	5
3.	Livestock-stunning pen, head-washing table, and plant walls and floor with rough surfaces and peeling paint	9
4.	Livestock-stunning pen and plant walls and floor in excellent condition	9
5.	Live weight of livestock slaughtered and electricity and gas used in 12 months at plant 11	11
6.	Slaughter-room illumination provided by suspended fluorescent lights	13
7.	Fabrication room with fluorescent lights suspended over work areas	13
8.	Slaughter room equipped with about 30 feet of perforated piping that sprays water continually on the floor in the bleeding and dressing areas	16
9.	Slaughter-room water hoses suspended from the ceiling to reduce wear to the hose walls and to clear the room floor of hoses	16
10.	Slaughter-room floor drain located in the dry-landing and bleeding area, with the cover missing	16

TABLES

1.	Plant size, volume slaughtered, and utility consumption and costs for 12 months	3
2.	Calculated and typical water usage for performing selected jobs at the 11 plants	5
3.	Water usage by operation	8
4.	Live weight of livestock slaughtered and energy used during 12 months	10

Page
5. Electricity used during 12 months, estimated kilowatts used for plant lighting, and light source 11
6. Lighting in slaughter room by source and watts per square foot of floor area 12
7. Live weight of livestock slaughtered and natural gas and propane used during 12 months 12
8. Suggested change in number of slaughter days weekly, based on weekly slaughter rates, with estimated savings in utility usage and labor 14

ACKNOWLEDGMENTS

The author acknowledges the cooperation of the plant owners and operators who permitted studies at their plants and provided information about their operations. Credit also is due the Oklahoma-Texas Meat Processors Association for their support and cooperation during this study.

UTILITY USAGE IN SMALL SLAUGHTER PLANTS

By Clayton F. Brasington[1]

ABSTRACT

Utility usage was studied at 11 small packing plants in Oklahoma and Texas. Generally, less than 125 head per week were slaughtered at each plant. Average water- and energy-usage guidelines were developed for plant designers and operators. Recommendations are made for reducing waste-water pollution and usage of water, electricity, and natural gas or propane by changing work procedures, upgrading equipment and facilities, and operating slaughter floors at or near capacity. If slaughter floors were operated at capacity, 10 of these plants could reduce annual water usage by 3 to 32 percent and energy usage by 2 to 21 percent. **KEYWORDS: beef, energy usage, goat meat, lamb meat, meat processing, mutton, pork, time-motion studies (slaughterhouse efficiency), waste disposal, water pollution, water usage.**

INTRODUCTION

Since 1970, protection of the environment and energy cost, two serious problems in the meat industry, have become increasingly important for operators of small slaughter plants. Most existing plants were not designed to control significantly the discharge of pollutants into waste water and the atmosphere or to regulate energy usage efficiently.

The issue is still in the courts, but small meat plants might not be forced to install expensive onsite waste-water quality-control equipment. However, most plants that discharge untreated effluent into municipal sewer systems can expect to pay a surcharge for the removal of the pollutants. Plants not using a municipal sewer service may be forced to control waste-water and surface drainage so that it does not contaminate local streams, underground water, and adjacent private property.

To date, air-quality problems have affected only a few of these plants. Complaints have been about nuisance odors from lagoons, feedlots, livestock pens, and storage of waste products. If a plant has to switch from natural gas or propane to fuel oil with a high sulfur content, emission-control equipment might be needed.

The rising cost of energy has forced plants to pass on some of the increase to customers. Most operators have been unable to develop a long-range energy-conservation program because they do not know what types of energy will be available in the future and how much energy will cost. Also, they do not know how their energy usage compares with similar plants. Little has been published on utility usage in small slaughter plants.

To provide some of the information needed by the small livestock-slaughter plants, the Meat Handling and Facilities Research Group of the USDA Agricultural Research Service (ARS), at College Station, Tex., conducted engineering studies of utility usage in 11 plants in Oklahoma and Texas. Plant selection was based on an average weekly livestock slaughter of no more than 125 head, all utilities on meters, a continuous operation for at least 12 months, providing customer services such as fabricating and packaging meat cuts in addition to livestock slaughter, the availability of past slaughter records, and the interest of the operator in cooperating in this research.

Three of the selected plants were constructed

[1] Industrial engineer, Agricultural Research Service, U.S. Department of Agriculture, College Station, Tex. 77840.

after January 1970. The remaining eight plants were much older but had been remodeled within the past 10 years to comply with Federal and State meat-inspection requirements.

The same information was collected at each plant. The operator provided the number of head slaughtered and dressed weight by species for 12 months and background information about the plant. The amount of water, electricity, and natural gas or propane used during the same period was obtained from the utility company or supplier. Records were made of: (1) the disposal procedures for blood, manure, and inedible offal, (2) the amount of water used during selected operations and the flow rate of the hoses, (3) the type and amount of lighting in the plant and footcandle readings at selected locations, and (4) when available, the number and horsepower of electric motors, the wattage of electric heaters, and the British-thermal-unit (Btu) rating of gas heaters. Also, sketches of the facility were prepared, and measurements were made of all areas studied.

Utility rate schedules in effect during January 1976 were obtained from a number of widely scattered towns in Texas and Oklahoma. Costs for water and sewerage were obtained at 14 places, for electricity at 15, for natural gas at 13, and for propane at 5. Energy costs increased substantially during 1976, and some suppliers of electricity and natural gas were again surveyed in 1977 so that the January 1976 rates could be adjusted to reflect January 1977 rates. The cost of electricity, based on nine suppliers contacted, increased an average of about 26 percent from January 1976 to January 1977. At the six companies contacted for the cost of natural gas, the increase averaged about 37 percent for the 12 months. Because only one plant used propane, two local suppliers were contacted, and their costs per gallon in January 1977 were about 22 percent higher than in January 1976. It was assumed that water and sewer costs did not increase enough to change significantly the rates obtained for January 1976.

The average cost of water and sewer service for a plant that used 50,000 gallons of water monthly was $38.89. The charge for sewer service averaged 22 percent of the total water and sewerage costs. The cost of electricity for 20,000 kilowatthours per month plus the fuel-cost adjustment and demand charge averaged $759.53. For the electrical rates, it was assumed that a demand of 38 kilowatts would apply to monthly usages up to 20,000 kilowatthours and a demand of 67 kilowatts would apply to usages of 20,000 kilowatthours or more. For 50,000 cubic feet of natural gas used monthly, the cost including the gas-cost adjustment averaged $106.28. The cost of propane for 100 gallons or more delivered averaged 40 cents a gallon.

Table 1 shows for each plant the building and holding-pen sizes, the volume of livestock slaughtered, and the utility requirements and costs for 12 months. Plant 2 had only slightly more building area than the average; however, it had the highest slaughter volume. Plant 9 shipped about 85 percent of the livestock slaughtered as chilled carcasses. Plant 10 slaughtered 3 days each week, the other plants 5 days. Several plants slaughtered a few livestock each week for local meat markets. These carcasses generally were picked up after they had been held overnight in the chill cooler. Three plants purchased some fresh meats from other packers to augment their supply or to provide customers with a certain quality or quantity of products. Generally, the purchased meats were a small percentage of the plant volume. No records were available on the amount purchased, and as a result these purchased meats were not included in the plant volume.

In table 1, utility consumption and costs were not allocated for the skinning and processing of deer at plants 3, 4, and 11. The plants kept records of the number of deer handled but not of the carcass weights. For these plants, utility consumption and costs per head and pound of live weight slaughtered are slightly higher than they would have been had the deer been included.

Use of water, electricity, and natural gas or propane varied widely among the 11 plants. Reasons for the differences might be the customer services available, the amount and condition of the space that was cleaned, heated, illuminated, and refrigerated, and the percentage of capacity at which the plant operated.

The utility costs per 1,000 pounds of live weight slaughtered averaged $7.10 for the 11 plants (table 1). Electricity made up about 84 percent of this cost, water and sewerage about 5 percent, and natural gas or propane about 11 percent.

From the information provided in table 1, an

TABLE 1.—*Plant size, volume slaughtered, and utility consumption and costs for 12 months*

Item	Plant 1	2	3	4	5	6	7	8	9	10	11	Average
						Plant size						
Building area ..... ft² ..	5,750	6,365	4,630	8,000	5,735	6,810	6,990	4,365	3,555	6,710	9,090	6,182
Holding-pen area ..... ft² ..	250	735	410	780	520	2,110	585	675	1,080	655	920	789
						Volume slaughtered						
Cattle slaughtered	1,195	5,346	948	1,180	2,072	1,792	3,338	1,905	2,341	936	2,182	2,112
Total live weight[1] ..... lb ..	929,220	3,616,865	638,872	881,613	1,562,878	1,547,636	2,357,489	1,238,596	1,320,327	506,787	1,747,618	1,486,173
Average weight per head ... lb ..	778	677	674	747	754	864	706	650	564	541	801	704
Hogs slaughtered	662	670	316	410	869	600	537	141	137	326	1,985	605
Total live weight[1] ..... lb ..	159,511	160,438	71,468	98,668	215,454	141,667	139,888	24,919	30,165	80,594	494,071	146,986
Average weight per head ... lb ..	241	239	226	241	248	236	260	177	220	247	249	243
Sheep and goats slaughtered	53	35	211	374	75	81	5	18	19	35	85	90
Total live weight[1] ..... lb ..	4,368	3,790	16,316	22,166	7,418	7,830	252	1,334	1,532	4,140	9,600	7,159
Average weight per head ... lb ..	82	108	77	59	99	97	50	74	81	118	113	87
Total animals slaughtered	1,910	6,051	1,475	1,964	3,016	2,473	3,880	2,064	2,497	1,297	4,252	2,807
Total live weight ..... lb ..	1,093,099	3,781,093	726,656	1,002,447	1,785,750	1,697,133	2,497,629	1,264,849	1,352,024	591,521	2,251,289	1,640,317
Deer skinned and processed	...	...	618	551	...	...	...	...	...	...	300	...
						Utility consumption and costs						
Water used ..... gal ..	492,400	756,000	357,700	788,390	610,613	555,000	950,100	413,000	511,700	455,000	824,481	610,398
Average per head ..... gal ..	258	125	[2]243	[2]401	202	224	245	200	205	351	[2]194	241
Average per pound ..... gal ..	0.45	0.20	[2]0.49	[2]0.79	0.34	0.33	0.38	0.33	0.38	0.77	[2]0.37	0.44
Electricity used ..... kWh ..	184,440	304,400	126,600	181,480	257,520	270,560	345,440	169,400	152,750	159,100	402,120	232,165
Average per head ..... kWh ..	97	50	[2]86	[2]92	85	109	89	82	61	123	[2]95	88
Average per pound ..... kWh ..	0.17	0.08	[2]0.17	[2]0.18	0.14	0.16	0.14	0.13	0.11	0.27	[2]0.18	0.16
Gas used[3] ..... ft³ ..	459,100	674,000	166,300	436,757	375,800	920,400	939,200	125,800	...	1,050,000	911,000	605,836
Average per head ..... ft³ ..	240	111	[2]113	[2]222	125	372	242	61	...	810	[2]214	251
Average per pound ..... ft³ ..	0.42	0.18	[2]0.23	[2]0.44	0.21	0.54	0.38	0.10	...	1.78	[2]0.40	0.47
Utility costs[4] ..... dollars ..	8,104	12,342	5,999	9,238	10,236	11,769	13,956	7,030	6,396	8,311	15,230	9,880
Average per head ..... do ..	4.24	2.04	[2]4.08	[2]4.70	3.37	4.76	3.60	3.41	2.56	6.46	[2]3.58	3.89
Average per pound ..... cents ..	0.74	0.33	[2]0.83	[2]0.92	0.57	0.69	0.56	0.56	0.47	1.42	[2]0.68	0.71

[1] Plant data were in dressed weight. Live weight was calculated by dividing total cattle weight by 55 percent, hog weight by 72 percent, and sheep and goat weight by 50 percent.

[2] Deer not included.

[3] Plant 4 used propane. 1 gal of propane is approximately equal (Btu content) to 91.5 ft³ of natural gas.

[4] The same averaged costs, based on January 1977 rates, were used for calculating costs at the 11 plants.

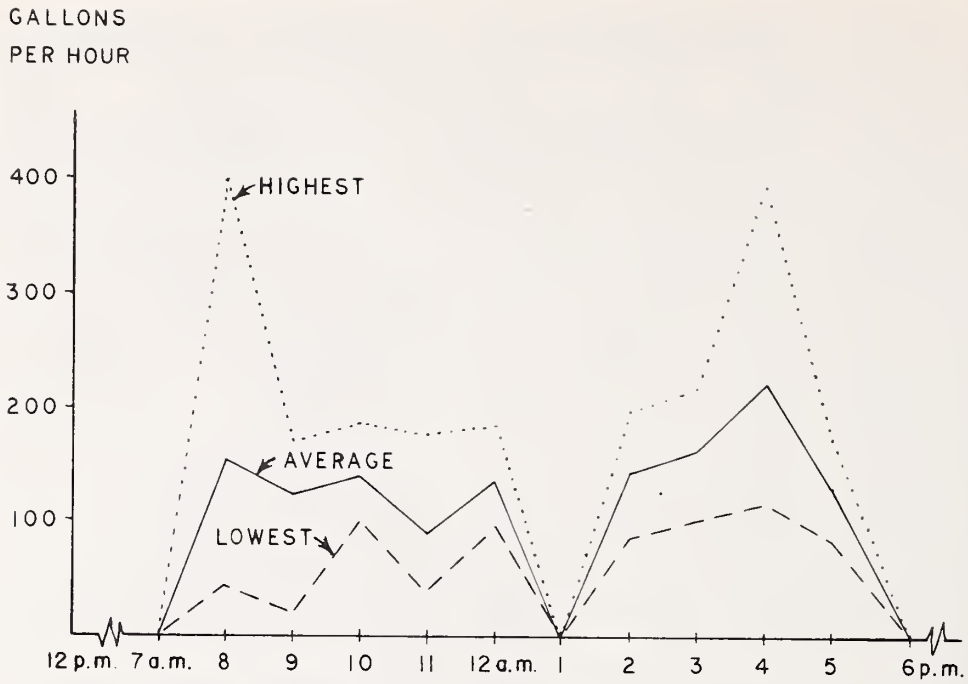

FIGURE 1.—Highest, lowest, and average hourly water usage for 5 days at plant 2.

operator can see how his plant compares with the ones studied. Designers can use these data to estimate utility requirements for an anticipated volume. Before starting construction, planners should check the estimated amounts needed with the local suppliers to see how much utilities will cost and if the amounts needed are available.

Information is provided in this report on water usage, waste management, and utility usage by operation and plant area. Changes in equipment, facilities, work procedures, and plant schedules are suggested to reduce wastewater pollution, water consumption, and energy requirements.

WATER USAGE

Measurement of Water Used

Water was used at most plants between 7 a.m. and 5 p.m. A few plants used water for about 14 hours each work day because a separate crew cleaned after the plant closed. Figure 1 shows for plant 2 the highest, lowest, and average hourly water usage for 5 slaughter days. Water consumption during the 5 days was 6,560 gallons.

Waterflow was measured for regular-pressure hoses and for high-pressure low-volume washers. A stopwatch and a 5-gallon container were used for the measurements. The highest flow rate at regular water pressure was 11.36 gallons a minute, the lowest was 3.76 gallons, and the average was about 5 gallons. The flow through a hose dropped slightly when another hose was used, and so the rate was not measured when other hoses were being used. Four of the plants had portable washers with electric pumps that increased the water pressure through a small-diameter hose and nozzle. Some of these high-pressure washers had a small tank of cleaning solution that could be mixed with the water before spraying. All had flow rates from 1½ to 3 gallons a minute (fig. 2).

Approximately 2½ days at each plant were devoted to recording water usage during livestock slaughter and plant cleanup. Table 2 lists the calculated and typical water usage for performing selected jobs. Calculated water usage includes all recorded observations, and in several instances it includes the same cleaning job done on 2 days at the same plant. Only the observations representative of small plants were used to compute the typical usage. When water used for a particular job at one or more plants was much lower or higher than at the other plants and no valid answer could be found for the difference, the plant or plants were elimi-

TABLE 2.—*Calculated and typical water usage for performing selected jobs at the 11 plants*[1]

Job		Water: Calculated usage	Water: Typical usage
Slaughter room:			
Cattle dressing:			
Head washing	gal/head	2.44	2.44
Offal-truck washing[2]	gal/head	3.23	2.33
Carcass washing[3]	gal/lb	0.03	0.03
Total per carcass[3]	gal/lb	0.09	0.09
Hog dressing:			
Carcass washing (skin off)[3]	gal/lb	0.07	0.09
Carcass washing (skin on)[3]	gal/lb	0.02	0.04
Total per carcass (skin off)[3]	gal/lb	0.14	0.15
Total per carcass (skin on)[3]	gal/lb	[4]0.35	[4]0.35
Sheep and goat dressing:			
Carcass washing[3]	gal/lb	0.18	0.18
Total per carcass[3]	gal/lb	0.36	0.36
Plant cleanup:			
Cleanup during slaughter:			
Between species	gal/ft^2	0.07	0.05
During work break	gal/ft^2	0.05	0.04
At end of day	gal/ft^2	0.27	0.27
Holding pens	gal/ft^2	0.19	0.19
Inedible-offal room	gal/ft^2	0.21	0.33
Chill cooler	gal/ft^2	0.07	0.09
Holding cooler	gal/ft^2	0.13	0.16
Fabrication room	gal/ft^2	0.27	0.23

[1] Some jobs were not performed during each visit or at all plants.
[2] Water usage per head was the same for cattle, hogs, sheep, and goats.
[3] Carcass live weight was used to calculate gallons per pound.
[4] Includes water in hog scald vat.

nated in computing the typical usage. Not all jobs were observed during the visit at a plant, and some jobs were not performed at every plant. For example, a few plants did not have an inedible-offal truck in the slaughter room. The typical water usage for performing the jobs listed in table 2 should not be considered as standards for small plants. The data can be used as a guide for comparing the same jobs at similar small plants and for estimating water requirements when planning new facilities.

Water Used During Livestock Slaughter

The washing of cattle heads after the heads are placed on a hook or rack was measured at three plants. The calculated and typical water usage was based on observing the washings of 22 cattle heads. Head washing at several additional plants was not included because the workers mixed this job with other unrelated washing.

FIGURE 2.—Cleaning an inedible-offal container with a high-pressure washer.

The washing of 33 inedible-offal trucks was observed at four plants. After the edible offal had been removed from the inspection pan, the inedible offal was dumped from the lower pan, the truck was tilted forward, and a hot-water hose was used to rise both pans. At one of the plants, the worker used about 10 gallons of hot water each time he washed the four trucks observed. He partially filled the upper and lower pans before he tilted the truck and rinsed it. Twenty-nine truck washings were included in computing the typical usage.

The water used to wash dressed cattle carcasses was recorded at all 11 plants. During the observations, 121 carcasses with an average live weight of 716 pounds were washed. Ninety-three carcasses with an average live weight of 779 pounds were included in computing the typical usage. Plants that used less than 0.02 or more than 0.06 gallon per pound of live weight were excluded. When the one plant that used less than 0.02 gallon per pound and the three plants that used more than 0.06 gallon were eliminated, the typical water usage was the same as the calculated usage (table 2). The plant that used less than 0.02 gallon per pound of live weight used slightly more than 62 gallons of water to wash seven carcasses. At the three plants that used more than 0.06 gallon, water was often wasted because the same carcasses were often washed by several workers and because good washing procedures were not employed.

The total water used per cattle carcass (table 2) includes washing the dressed carcass and rinsing off the floor, walls, and equipment during the slaughter of an animal. Seven of the plants had from two to five hoses in the slaughter room. Four plants had small one-head-at-a-time slaughter rooms and only one hose for washing carcasses and cleaning. Water usage was recorded for 111 carcasses with an average live weight of 716 pounds. Water usage ranged from 0.04 to 0.16 gallon per pound of live weight. Typical water usage was based on observations at 7 plants where 61 carcasses were prepared using from 0.06 to 0.13 gallon per pound of live weight. The two plants that averaged less than 0.06 gallon did not rinse the floor, walls, and equipment as thoroughly or as often as was considered typical for these plants. Excessive water usage at one plant occurred because workers often used a hose to act busy while waiting for work. The plant that used 0.16 gallon per pound had a continuous water spray over the edible-offal inspection pan. If the spray unit had a foot- or knee-operated valve to control waterflow, the water used for this job could be reduced at least 50 percent.

Five plants washed skinned hog sides during visits. Thirty-seven carcasses were observed with an average live weight of 231 pounds. Typical usage ranged from 0.07 to 0.11 gallon per pound of live weight. Twenty-one hogs with an average live weight of 241 pounds were in the typical-usage group.

Two plants had hog scald vats and mechanical dehairers. Hogs were not skinned on days when this equipment was in operation. Twenty-one carcasses were dehaired during visits; however, only eight carcasses were prepared in a typical manner. The 13 hogs that were not typically prepared were washed and placed unsplit in the chill cooler. The water used to wash the 13 carcasses averaged less than 3 gallons per carcass. The average live weight for the 21 carcasses was 303 pounds and for the 8 typically prepared carcasses 264 pounds.

The total water used per hog carcass includes the same jobs performed during the slaughter of cattle. Twenty-eight skinned hog carcasses were observed at five plants. Typical water usage was based on observations at 3 plants that slaughtered 17 head with an average live weight of 246 pounds. From 0.13 to 0.19 gallon of water per pound of live weight was the typical usage.

The water needed to fill the scald vat was included in the total used for skin-on hog slaughter. The more hogs handled, the smaller the amount of scald-vat water allocated to each pound of live weight. At the plant that slaughtered eight hogs weighing an average of 264 pounds each, about 0.69 gallon of water was needed per pound of live weight. Typical usage was considered the same as calculated usage because only two plants were observed, and these plants used the scald vat when as few as five hogs were scheduled for slaughter.

The washing of sheep and goat carcasses was measured at three plants. Twelve carcasses were washed during observations, and the average live weight per head was 61 pounds. Calculated and typical usage was assumed to be the same because of the small number of animals slaughtered.

Because the observations on total water usage for sheep and goat dressing were limited to 11 head at 2 plants, calculated and typical usage are assumed to be the same. The average live weight for each of the 11 animals was 54 pounds.

Water Used During Plant Cleanup

When a plant changed from one species to another during slaughter, usually a portion of the floor and walls and some of the equipment were rinsed with water before the first carcass was dressed. Five observations of cleaning between species were recorded. Typical water usage ranged from 0.02 to 0.07 gallon per square foot of floor area. At one plant where the cleaning was not considered typical, about 0.12 gallon of water was used per square foot of floor area. The worker who cleaned between species used the job as a 10-minute rest period, for he stood in the center of the room and indiscriminately sprayed water on the walls, floor, and equipment.

At most plants, the slaughter workers took midmorning and afternoon breaks in addition to a lunch break. When work ceased, usually one worker stayed in the room and used a hose to wash blood, soil, and trimmings to the floor drains. The accumulated material was picked up and placed in an inedible-offal container or forced through the drain cover if the holes were large, or the drain cover was removed and the material washed down the drain. Fourteen observations were made, and the water usage ranged from 0.02 to 0.05 gallon per square foot of floor area.

The slaughter-room cleanup at the end of the day included a thorough cleaning of the floor, walls, doors, and equipment. Workers at most plants used brushes, brooms, and cloths and cleaning solutions to remove blood, grease, and other soil from room surfaces and equipment. Carcass-splitting saws, mechanical skinning knives, and other power equipment were normally taken apart and cleaned. After the room and equipment had been scrubbed with the cleaning solution, one or more hoses were used to rinse them. Only one plant used a high-pressure washer in addition to a hose at regular water pressure. The high-pressure washer was used to apply the cleaning solution, and the hose at regular water pressure was used to rinse the solution off the surfaces. The high-pressure washer had a flow rate of 2½ gallons a minute, and the hose at regular water pressure had a flow rate of 5.49 gallons a minute. About 0.43 gallon of water and cleaning solutions was used per square foot of floor area. At the 10 plants that used hoses at regular water pressure, water usage ranged from 0.13 to 0.37 gallon per square foot of floor area. The cleaning of the hog scald vat and dehairer at two plants was not included. Since the condition of the room surfaces, number of items and equipment and ease of cleaning, and amount of wall, door, and floor area cleaned all affected the amount of water used, the calculated and typical water usages for this job are considered the same (table 2).

The holding pens at many plants were cleaned daily. This job was observed at 8 of the 11 plants. The cleaning at seven plants involved a hose at regular water pressure to wash the soil off the fence rails and gates and move the soil on the floor to the drains. Calculated and typical water usage ranged from 0.14 to 0.25 gallon per square foot of floor area. The cleaning worker at one plant used a push broom to gather most of the material into piles and a shovel to put the material into a container. At this plant, water usage was the lowest, 0.14 gallon per square foot. Another plant that needed only 0.14 gallon of water to clean the pens utilized a high-pressure washer with a flow rate of 2½ gallons a minute. At a third plant, the worker covered the floor drains and flooded the holding-pen floor after the last animal had been driven into the stun pen. When he was ready to clean this area, he removed the drain covers and then washed the fences, gates, and floor. The water needed to clean the holding pens was 0.20 gallon per square foot of floor area; however, if the water he used to flood the area is included, about 0.35 gallon per square foot was used.

The inedible-offal room normally was cleaned after the renderer had picked up the offal. A hot-water hose was used to wash off the walls, doors, and floor. The material on the floor was either put into a container or washed down a floor drain. This cleaning was observed at five plants. The cleaning of the inedible-offal room at two plants was eliminated from the typical usage because it was inadequate; less than 0.10 gallon of water was used per square foot of floor area.

TABLE 3.—*Water usage by operation*[1]

[Percent]

Operation	Plant							Average
	2	3	5	6	7	8	9	
Wash carcasses, floor, and equipment during slaughter	25.85	28.08	22.15	16.45	42.45	37.27	42.12	30.62
Clean slaughter and inedible-offal rooms	7.79	11.14	12.67	24.39	7.16	9.20	21.30	13.38
Clean holding pen	4.79	7.20	4.41	6.68	3.25	7.13	(2)	5.58
Clean chill and hold coolers	2.45	.37	1.59	.79	1.94	(2)	.89	1.34
Clean fabrication room	19.26	3.39	27.20	11.45	9.56	7.06	2.44	11.48
Clean remainder of plant	1.22	4.09	14.24	.17	2.40	1.05	(2)	3.86
Employee needs[3]	17.86	17.36	15.82	14.92	10.17	15.04	16.01	15.31
Subtotal	79.22	71.63	98.08	74.85	76.93	76.75	82.76	...
Unaccounted-for water usage[4]	20.78	28.37	1.92	25.15	23.07	23.25	17.24	...
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	...

[1] Based on time studies of water usage and flow rates for hoses used in performing operations.
[2] Cleaning not observed during study.
[3] Based on number of employees, days worked annually, and an estimated 25 gal per day per employee.
[4] Includes all unobserved usage.

The cleaning of the chill cooler was observed at nine plants. This cooler was often cleaned early in the workday, when the room was empty or had only a few carcasses in it. The room doors and walls, when needed, were washed, and fat and other scraps on the floor were either scraped loose or melted loose with hot water. The loosened scraps and blood were washed to the floor drains. Two plants used hot-water high-pressure washers to clean these coolers. Water usage per square foot of floor area was 0.05 gallon at one plant and 0.08 gallon at the other. Based on the measurements made at the nine plants, the high-pressure washers seemed to remove the material on the floor better than the hoses at regular water pressure; however, water usage per square foot was about the same. At the five plants where observations were made, typical water usage ranged from 0.08 to 0.12 gallon per square foot of floor area.

Hold coolers were generally cleaned at the end of the day in the same manner as the chill coolers. Cleaning was observed at four plants; however, at one plant the cleaning was considered inadequate and was eliminated from the typical-usage calculations (table 2). Typical water usage ranged from 0.14 to 0.17 gallon per square foot of floor area.

The cleaning of the fabrication room at the end of the day was handled either by the regular plant workers or by a different crew that came in after the plant had closed. Fabrication-room cleaning was observed at 10 plants. At eight plants, the plant workers also cleaned the fabrication room. Cleaning generally included disassembling equipment, removing the fat, bone dust, and trimmings from equipment and floors, using cleaning solutions and brushes and cloths to wash equipment and the facility, and rinsing the equipment and area with hot water. One plant used a high-pressure washer to apply the cleaning solution and rinse it off, and three plants used high-pressure washers in conjunction with hoses at regular water pressure. Three of the older plants used 0.10 gallon or less per square foot of floor area. This low usage was primarily because of the type of walls and floor in the room. More time was devoted to hand-washing carefully and rinsing the equipment and area, and only a limited amount of cleaning was done with a hose. At one plant, two workers used hoses at regular water pressure to wash the fat, bone dust, and trimmings off the equipment and to the floor drains, and they used cleaning solutions and brushes only when hot water would not clean adequately. As a result, 0.91 gallon of water was used per square foot of floor area. The observations at six plants were considered typical, and usage ranged from 0.18 to 0.33 gallon per square foot of floor area.

Analysis of Water Usage

The measurements of water usage during livestock slaughter and plant cleanup were analyzed for each plant. The results, along with the information obtained on slaughter by species for 12 months, the number of days the plants operated annually, and the water used during the same period were used to compute the percentage of water used by operation (table 3). Only seven plants are shown because at three plants the unaccounted-for water usage exceeded 30 percent, and at one plant the fabrication-room cleaning was not observed. The average percentages shown in table 3 should be a good measure of the water used for each operation listed and should be helpful in the evaluation of similar small slaughter plants. A factor that affected the amount of water used in performing these operations, but which could not be evaluated, was the amount of cleaning actually needed. At plants with worn and cracked walls and floors and old equipment, generally more water was used than at plants with smooth walls and floors and modern, galvanized or stainless-steel equipment (figs. 3 and 4).

WASTE MANAGEMENT

A municipal sewerage-treatment service was used by 10 of these plants. The remaining plant used a large pit on the property for disposal of liquid wastes because the nearest sewerline for the town was about a mile away. Five plants bled livestock into containers that were picked up by the renderer, and six bled into the sewer system. Two reasons given for bleeding into the waste-water lines were that the town did not have a surcharge for the pollution loading of waste water and that the renderer's truck did not pick up blood.

Only one plant of the five that bled livestock into containers had adequate equipment to catch the blood. This plant placed a light-weight large-diameter funnel on the container and little blood spilled onto the floor. The other plants had either metal or plastic containers with openings about 2 feet in diameter. If the worker did not carefully position each carcass, a large amount of blood often missed the container opening.

The stomach contents had to be removed from paunches before most rendering companies would accept them. None of the plants had a paunch table, and the workers either dumped the paunch contents directly into a container or emptied them onto the inedible-offal room floor and shoveled the material into a container. Plants had to arrange for the disposal of the stomach contents.

The manure on the floors of the holding pens and drive alleys was washed down the floor drains at 10 of these plants. At one plant, most of the manure was collected and put into containers before the floor was washed. The waste-water lines serving the floor drains in the holding pens, the inedible-offal room, and the slaughter room often had a sump that allowed most of the dirt and heavier waste material to

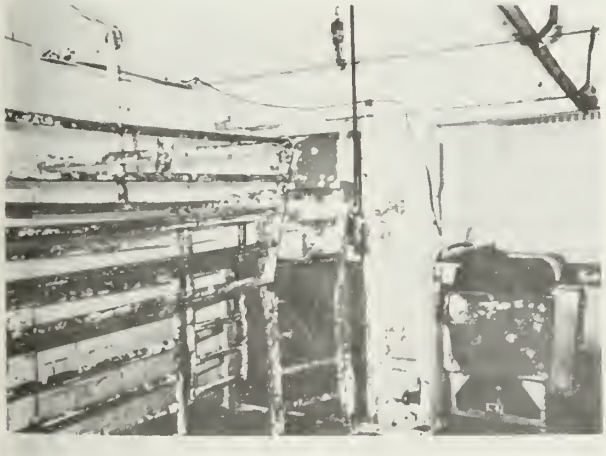

FIGURE 3.—Livestock-stunning pen, head-washing table, and plant walls and floor with rough surfaces and peeling paint.

FIGURE 4.—Livestock-stunning pen and plant walls and floor in excellent condition.

TABLE 4.—*Live weight of livestock slaughtered and energy used during 12 months*[1]

Plant	Live weight (pounds)	Energy used[2] (1,000 Btu)	
		Total	Per 1,000 pounds
1	1,093,099	1,088,594	996
2	3,781,093	1,712,917	453
3	726,656	598,386	823
4	1,002,447	1,056,148	1,054
5	1,785,750	1,254,716	703
6	1,697,133	1,843,821	1,086
7	2,497,629	2,118,187	848
8	1,264,849	703,962	557
9	1,352,024	521,336	386
10	591,521	1,593,008	2,693
11	2,251,289	2,283,436	1,014
Average	...	...	965

[1] Plant data were in dressed weight. Live weight was calculated by dividing total cattle weight by 55 percent, hog weight by 72 percent, and sheep and goat weight by 50 percent.

[2] Based on 1 kWh of electricity being equal to 3,413 Btu, 1 ft^3 of natural gas equal to 1,000 Btu, and 1 gal of propane equal to 91,500 Btu.

settle out before the effluent was discharged. Periodically, the sump was cleaned by pumping the material into a tank truck.

These plants usually had a grease trap in the sewerlines that served most of the floor drains, hand-wash lavatories in work rooms, and equipment-wash sinks. The grease was removed from the traps and put into inedible-offal containers. This operation was not observed during visits at the plants.

Only a few plants had equipment available in workrooms to collect the soil on the walls, floor, and equipment and to put this material into containers prior to cleaning the area. Water pressure was used to loosen material and to push it to the floor drains. Workers generally picked up little of this soil, and often they removed drain covers so that all the material could be washed down the drain. Floor drains stopped up frequently, and a worker had to quit his assigned job to clean out the drain line.

ENERGY USAGE

Adequate, dependable supplies of energy were available at these plants. Plant 9 was all electric. In general, the plants used electricity to power equipment and for lighting, and they used natural gas to heat water and to operate smokehouses and space heaters. Plant 4 used propane because natural gas was unavailable.

Electricity, natural gas, and propane consumption has been converted to British thermal units to provide a common base for comparison. In this report, 1 kilowatthour of electricity is equivalent to 3,413 Btu, 1 cubic foot of natural gas is equivalent to 1,000 Btu, and 1 gallon of propane is equivalent to 91,500 Btu.

The energy used per 1,000 pounds of live weight slaughtered at the 11 plants is shown in table 4. Plant 9 had the lowest energy usage per 1,000 pounds of live weight; however, approximately 85 percent of the livestock slaughtered were loaded out as chilled carcasses. Also, the freezer was the smallest at the 11 plants. The only plant that used more natural gas than electricity was plant 10. This plant had gas-operated refrigeration equipment for a portion of the facility. Probably, the major reason for plants 6 and 10 having the highest energy requirements is that they were estimated to be operating at between 50 and 75 percent of capacity. Plants 5, 8, and 9 did not cure or smoke meats. Plant 2 was the only one that was estimated to be operating near capacity.

The slaughter and energy records for 12 months at these plants indicate that the energy consumed monthly was often influenced more by the season than by changes in the volume of livestock slaughtered. During the warm months, more electricity was used. Natural-gas and propane usage was higher during the cool months because more products were cured and smoked, water heated for cleaning had a lower initial temperature, and furnaces and space heaters were in operation. Plant 11 is a good example of how changes in the weight of livestock slaughtered had no marked affect on energy usage (fig. 5). From May through September, usage of electricity was the highest; however, May, June, and July were the third, first, and fourth lowest months in slaughter volume. Natural-gas consumption was lowest during June, July, August, and September and was highest in January.

It was possible to estimate only the amount of electricity used for lighting, because records were not kept of the quantity of products prepared with bandsaws, meat grinders, and other power equipment. Table 5 shows the estimated kilowatts used for lighting each plant, the percentage of the total energy used for lighting,

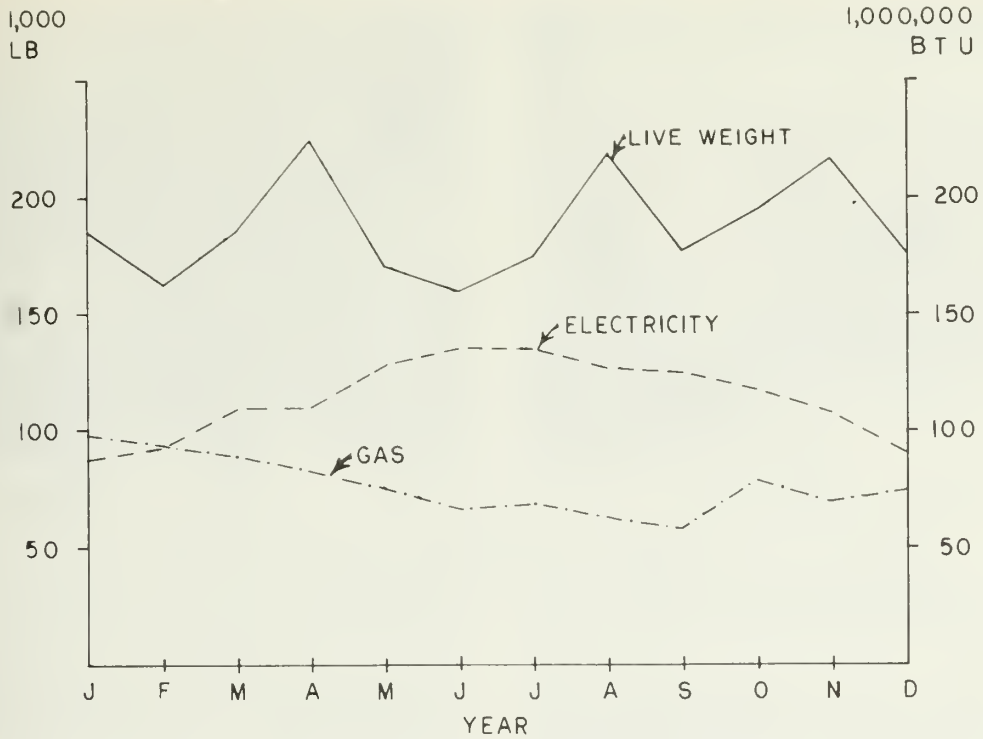

FIGURE 5.—Live weight of livestock slaughtered and electricity and gas used in 12 months at plant 11.

TABLE 5.—*Electricity used during 12 months, estimated kilowatts used for plant lighting, and light source*

Plant	Total electricity (kilowatts)	Plant lighting[1]		Light source (kilowatts)		
		Kilowatts	Percent	Incandescent	Fluorescent	Mercury vapor
1	184,440	13,840	7.50	3,250	10,590	...
2	304,400	13,445	4.42	7,125	6,320	...
3	126,600	18,360	14.50	14,000	3,440	920
4	181,480	27,805	15.32	16,625	11,180	...
5	257,520	20,988	8.15	4,938	16,050	...
6	270,560	26,080	9.64	7,550	16,690	1,840
7	345,440	25,905	7.50	10,125	15,780	...
8	169,400	20,260	11.96	14,000	6,260	...
9	152,750	20,580	13.47	2,250	18,330	...
10	159,100	35,192	22.12	2,688	24,270	8,234
11	402,120	31,815	7.91	12,375	19,440	...

[1] Kilowatt requirements for incandescent and fluorescent lights are based on lights in use for 10 hours daily for 250 days, and for mercury-vapor (outside security) lights 12 hours daily for 365 days.

and the number of kilowatts used for incandescent, fluorescent, and mercury-vapor lamps. Incandescent and fluorescent lights were used inside the facility and over the unloading area and holding pens. At several plants, mercury-vapor security lights (with photoelectric controls to turn the lights on at dusk and off at dawn) were used on outside poles (table 5). Energy usage for lighting was computed by assuming that the interior lights were on 10 hours daily for 250 days a year and that the security lights were on 12 hours daily for 365 days. Plant 10 used almost 7 percent more electricity for lighting than the next highest plant,

TABLE 6.—*Lighting in slaughter room by source and watts per square foot of floor area*

Plant	Slaughter-room area (square feet)	Light source (watts)		Total light (watts)	Average watts per square foot
		Incandescent	Fluorescent[1]		
1	365	450	672	1,122	3.07
2	473	1,500	...	1,500	3.17
3	353	1,800	...	1,800	5.10
4	828	...	1,204	1,204	1.45
5	732	200	1,376	1,576	2.15
6	1,200	...	1,032	1,032	.86
7	833	...	1,588	1,588	1.91
8	364	1,200	688	1,888	5.19
9	819	...	3,072	3,072	3.75
10	368	...	860	860	2.34
11	1,294	...	2,304	2,304	1.78

[1] Fluorescent wattage includes the bulb- and ballast-electricity requirements. Most 2-bulb fixtures with 40-watt bulbs require a 16-watt ballast unit, and with 75-watt bulbs a 22-watt ballast unit.

probably because of more outside security lighting and some gas-operated refrigeration equipment. At these plants, lighting averaged about 39 percent incandescent and 61 percent fluorescent. Fluorescent lamps provide about three times more illumination per watt than incandescent lamps. Table 5 indicates that for the six plants that used less than 10 percent of the electricity for lighting, five had more watts of fluorescent lights. However, the lighting needs of each plant varied considerably.

At some plants, a light meter was used to measure footcandles at selected locations in the slaughter room. A few plants, at the time of the visit, did not provide the 50 footcandles of illumination required at points where the carcass or carcass parts were subject to inspection. Bulbs were burned out, and reflectors and bulb covers were dirty. Illumination manuals state that dirt buildup on the bulb, the cover, and the reflector can reduce light by as much as 50 percent.

Slaughter-room lighting by source and watts per square foot of floor area is shown in table 6. Plants 1, 3, 8, and 10 had a one-head-at-a-time slaughter floor, and almost the entire room required 50 footcandles of illumination. Plant 8 had the highest lighting wattage per square foot of floor area, because several years ago the plant installed four two-bulb fluorescent units in addition to the eight incandescent lights in the room to comply with State requirements. At plant 6, most of the fluorescent lights were located over the work and inspection areas, and this plant had the lowest wattage per square foot (figs. 6 and 7).

TABLE 7.—*Live weight of livestock slaughtered and natural gas and propane used during 12 months*[1]

Plant	Live weight (pounds)	Natural gas or propane used[2] (1,000 Btu)	
		Total	Per 1,000 pounds
1	1,093,099	459,100	420
2	3,781,093	674,000	178
3	726,656	166,300	229
4	1,002,447	436,757	436
5	1,785,750	375,800	210
6	1,697,133	920,400	542
7	2,497,629	939,200	376
8	1,264,849	125,800	99
9	1,352,024	([3])	([3])
10	591,521	1,050,000	1,775
11	2,251,289	911,000	405

[1] Plant data were in dressed weight. Live weight was calculated by dividing total cattle weight by 55 percent, hog weight by 72 percent, and sheep and goat weight by 50 percent.

[2] Based on 1 ft^3 of natural gas equal to 1,000 Btu, and 1 gal of propane equal to 91,500 Btu.

[3] Plant 9 used only electricity.

The natural gas or propane used per 1,000 pounds of live weight slaughtered is shown in table 7. Plant 8 used natural gas only to heat water and consumed the smallest amount. Plant 2 had the next lowest requirement, possibly because it was operating at about 100 percent

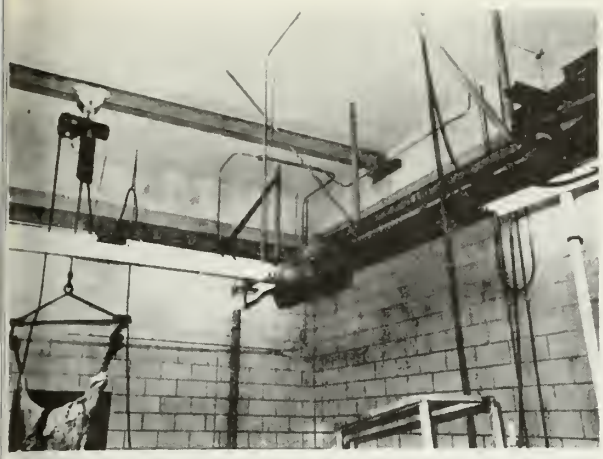

FIGURE 6.—Slaughter-room illumination provided by suspended fluorescent lights.

FIGURE 7.—Fabrication room with fluorescent lights suspended over work areas.

of capacity. Plant 10, with some gas-operated refrigeration equipment and central heat in a portion of the plant (plus operating at an estimated 50 percent of capacity), had the highest usage. Plant 4 and 11 had hog scald vats. The natural gas required to heat the water in a scald vat could be the major reason why the energy requirements exceeded 400 Btu per 1,000 pounds of live weight slaughtered. Plant 6, estimated to be operating between 50 and 75 percent of capacity, used the second highest amount of natural gas per 1,000 pounds of live weight slaughtered. Plant 1 used natural gas to operate a small smokehouse, a rendering kettle, and two water heaters.

SUMMARY AND CONCLUSIONS

The water, electricity, and natural gas or propane consumption per head of livestock and per pound of live weight slaughtered varied widely among the 11 plants studied. Utility usage per pound of live weight slaughtered ranged from 0.20 to 0.79 gallon for water, from 0.08 to 0.27 kilowatthour for electricity, and from 0.10 to 1.78 cubic feet for natural gas or propane. Variations resulted primarily from the customer services available, the amount and condition of the space that was cleaned, heated, illuminated, and refrigerated, and the percentage of capacity at which the plant operated.

Total water used per pound of live weight slaughtered averaged 0.44 gallon. At seven plants, water used during the slaughtering of livestock averaged 31 percent of the total plant consumption. Slaughtering livestock and cleaning of holding pens, slaughter rooms, and inedible-offal rooms accounted for about 50 percent of the water consumed at these seven plants.

Energy used per pound of live weight slaughtered averaged 965 Btu. Electricity for plant lighting ranged from 4 to 22 percent of the total plant consumption. More electricity was used during warm months because the refrigeration equipment had to operate for longer periods. Gas usage increased during cool months because more products were cured and smoked, water heated for cleaning had a lower initial temperature, and furnaces and space heaters were in operation.

Pollution loading of waste water and utility usage can be reduced by changing cleaning procedures, upgrading facility maintenance, and replacing inefficient and inadequate equipment. Additional reductions in utility usage can be realized by operating the slaughter rooms at or near capacity. Ten of the plants studied could reduce annual water usage from 3 to 32 percent and energy usage from 2 to 21 percent, if the slaughter rooms were operated at capacity.

An efficient plant operates at or near capacity. Because many plants cannot operate efficiently throughout the year by relying only on customers that raise or purchase livestock for custom slaughtering and processing, these plants often purchase carcass meats and livestock to slaughter and sell as wholesale or retail cuts. A few operators also contract with grocery stores and other food outlets. Some managers attract enough volume to operate near capacity throughout the year. Their annual utility re-

TABLE 8.—*Suggested change in number of slaughter days weekly, based on weekly slaughter rates, with estimated savings in utility usage and labor*[1]

Item	Plant 1	2	3	4	5	6	7	8	9	10	11
Slaughter-room capacity[2] ..... carcasses	16	32	16	32	32	32	32	16	40	16	40
Chill-cooler capacity[3] ..... do	16	30	16	25	26	35	40	18	30	60	45
Weekly slaughter rate:											
Highest ..... do	49	141	34	54	87	67	106	49	98	41	95
Lowest ..... do	28	99	23	23	37	37	55	32	11	15	69
Average ..... do	38	121	30	39	60	50	78	41	50	26	85
Present weekly slaughter ..... days	5	5	5	5	5	5	5	5	5	3	5
Suggested average weekly slaughter ..... do	3	5	2	2	3	2	3	3	2	2	3
Annual savings:											
Water and sewer service ..... gal	23,400	...	43,400	57,900	45,300	105,300	42,400	26,800	164,400	12,700	50,550
Electricity ..... kWh	1,870	...	4,050	5,210	6,120	12,670	4,580	4,240	31,900	2,610	6,460
Natural gas or propane[4] ..... ft^3	16,800	...	25,800	34,320	26,800	62,430	25,140	15,890	([5])	7,530	82,740
Annual cost savings for all utilities[6] ..... dollars	124	...	272	385	321	680	239	216	1,380	128	424
Annual savings in labor ..... man-hours	97	...	257	353	213	552	754	238	798	65	617

[1] Monthly slaughter records for 12 months and an assumed annual operation of 50 weeks were used to compute weekly slaughter rates.
[2] Based on room size and the slaughter of 1 animal per man-hour.
[3] Based on an average of 2 ft of overhead rail needed to hold 1 carcass. Some coolers are used both to chill and hold carcasses.
[4] Plant 4 used propane. 1 gal of propane is approximately equal (Btu content) to 91.5 ft^3 of natural gas.
[5] Plant 9 used only electricity.
[6] The same averaged costs, based on January 1977 rates, were used for calculating costs at the 11 plants.

quirements normally are lower per unit produced than those who operate at or near capacity for a portion of each year.

One way to lower utility usage during low-volume periods is to reduce the number of days the slaughter floor is in use. The number of days the remainder of the plant is open would be unchanged.

In this study, 10 of the plants slaughtered livestock 5 days each week, an average of 251 days annually (about 50 equivalent weeks), and 1 plant slaughtered 3 days weekly, an average of 153 days annually (about 31 equivalent weeks). It is assumed that all 11 plants operated 50 weeks annually.

The approximate capacity of the plants was determined by estimating the number of livestock that could be slaughtered during an 8-hour day and the number of carcasses that could be placed in the chill cooler. From observations made during visits to these and similar plants, about one animal per hour could be slaughtered, dressed, and placed in the chill cooler for each skilled worker assigned to the crew. If slaughter workers did not have to unload livestock, perform maintenance, and do other unrelated jobs, the slaughter rate per man-hour for all species would average about 1½ head. To determine the chill-cooler capacity, the length of usable overhead storage rail was computed and divided by a 2-foot allowance per carcass. This 2-foot allowance is based on a mix of cattle, hogs, sheep, and goat carcasses in the chill cooler.

Table 8 lists estimated capacities of the slaughter rooms and chill coolers, weekly slaughter volumes, present and suggested slaughter days weekly, and annual utility and labor savings that might be realized if most of these plants reduced the number of slaughter days weekly. During the 12 months covered by the monthly volume records obtained at each plant, only plant 2 operated at or near capacity throughout the year. No change in the number of slaughter days is suggested for this plant. All the plants should increase or decrease the number of slaughter days weekly to meet the changes in the number of head available for slaughter. Plants 1, 3, 8, and 10 have one-head-at-a-time slaughter floors and two full-time skilled workers probably would be required during peak-volume periods. At plants where the chill-cooler capacity is less than the slaughter-room capacity, a part-time slaughter worker can be employed to balance the daily slaughter rate with the cooler capacity. A few plants may have to add a second skinning cradle or replace some power equipment with more efficient units to reach the slaughter rate shown in table 8. Also, plant managers may have to schedule livestock deliveries either the afternoon before or early on the slaughter day so that the workers will not have to wait for animals.

The estimated annual utility and labor savings are based on what would be conserved if the slaughter rooms are idle. The savings include water to clean up the chill coolers, slaughter rooms, and holding pens and to fill hog scald vats; electricity for lighting, exhaust fans, and small-tool sterilizers; natural gas or propane to heat water for cleaning and for hog scald vats; and labor to clean the holding pens, chill coolers, and slaughter rooms. The annual dollar savings for utilities are computed from the same rate schedules used for table 1. An hourly wage rate for cleaning workers is not assumed because some plants have one or more plant workers to clean at the end of the slaughter day, and other plants have students or contract workers to clean after the plant closes. The wage rate plus social security and other fringe benefits for the slaughter workers could be twice the amount paid to unskilled workers. The utility savings are much higher for plant 9 because a continuous water sprayer over the edible-offal pan is eliminated on 3 days weekly, as well as for the cleaning at the end of the day. Also, this plant had the most lighting wattage in the slaughter room.

Plants should realize savings in addition to those shown in table 8 if they reduce the number of slaughter days to match the capacity of the plant. One of these savings would be in the amount of electricity needed to operate the chill cooler. On days when the slaughter room is idle, the refrigeration equipment has only to maintain the room temperature. When the slaughter room is in operation, the additional carcasses placed in the cooler will add to the heat load; however, the total electricity needed for refrigeration should be less than at the present.

Comprehensive plans for utility conservation and waste management for the entire plant require some changes that can be accomplished immediately at little or no expense and other modifications that are costly and can be realized

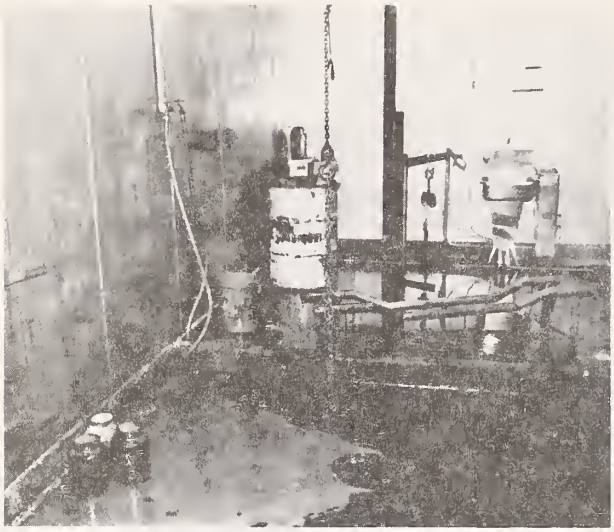

FIGURE 8.—Slaughter room equipped with about 30 feet of perforated piping that sprays water continually on the floor in the bleeding and dressing areas.

FIGURE 9.—Slaughter-room water hoses suspended from the ceiling to reduce wear to the hose walls and to clear the room floor of hoses.

only by remodeling or installing more efficient equipment.

Some changes that can be effected right away are:

1. Eliminate continuous water sprays (fig 8). A 1-gallon-per-minute water spray operated 8 hours daily for 250 days annually results in 120,000 gallons wasted.

2. Repair or replace leaking water valves, fittings, and hoses. Several small leaks can mean wasting a gallon a minute.

3. Place shutoff nozzles, preferably the trigger-type, on all hoses in general use (fig. 9).

4. Use metal scrapers or rubber squeegees rather than water to loosen material stuck to floors.

5. Require employees to use squeegees, scrapers, brooms, and shovels to preclean floors, walls, and equipment and to put the waste material into containers before water is used for cleanup.

6. Replace missing floor-drain covers and secure all covers (fig. 10) to prevent workers from washing waste material down the drains, in turn minimizing clogging of drains and reducing pollution loading of waste water.

7. Use largemouthed containers or bleeding funnels over barrels to catch more of the blood at plants that bleed stuck animals into containers. This procedure should reduce both the water needed to clean the bleeding area and the pollution discharged in the plant effluent.

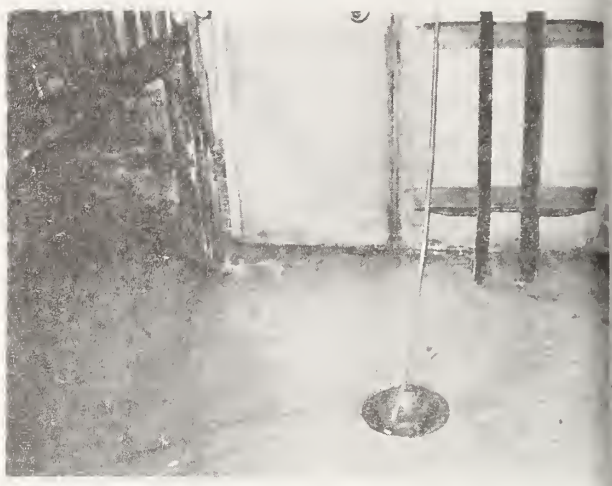

FIGURE 10.—Slaughter-room floor drain located in the dry-landing and bleeding area, with the cover missing.

8. Dump paunch contents into containers rather than onto the inedible-offal floor. When filled paunches are too heavy to lift and have to be emptied onto the floor, a squeegee should be used to push the paunch contents onto a shovel for transfer to the container.

9. Repair or replace worn gaskets and defective door hinges and fasteners for doorways of refrigerated rooms.

10. Reduce infiltration of warm air when refrigerated-room doors are open by installing double-swing doors or by hanging weighted plastic curtains in the doorway. With this arrangement, the doorway is open only when

products or personnel pass through the opening. Some plants install an air-curtain blower over the doorway to direct a low-velocity air barrier across the opening, instead of the double-swing doors or curtain.

11. Reduce the natural gas or propane used to heat water by setting the temperature control on the water heater to pilot when cleanup is completed on Friday night, and reset to normal when the plant opens on Monday morning. Plants that heat water with electricity can cut off the heater on Friday and restart on Monday. If gas or propane heaters are cut off at the main valve, the heating flues through the water tank may rust out prematurely because of sweating when the pilot is off.

Some of the changes that can reduce utility consumption but that can be expensive are:

1. Insulate all hot-water piping. In areas that are cleaned regularly, use a durable, easy-to-clean cover to protect the insulation.

2. Add or replace insulation in refrigerated areas if a minimum amount was installed when the plant was constructed, or if the insulation has deteriorated.

3. Inspect vapor barriers in refrigerated areas before installing new insulation. A vapor-barrier leak allows moisture to infiltrate insulation, reducing significantly the insulation efficiency. An accumulation of sweat, frost, or ice on an outside wall or ceiling surface is a good indication that the vapor barrier should be repaired in that area.

4. Reduce solar heat on exterior refrigerated walls located on the south and west side by erecting a wall to shade the existing one. The second wall should be spaced to allow air to circulate between the two walls.

5. Reduce solar heat on ceilings over refrigerated rooms by coating the roof with aluminum paint or other types of reflective material.

6. Replace incandescent lights with more efficient lighting in areas where the lights are on most of each workday. High-intensity lights such as mercury vapor or metal halide provide more illumination per watt, and the bulbs last longer than incandescent lights; however, the local meat inspector can reject the type of lighting provided in areas subject to his inspection. Written approval should be obtained from the appropriate inspection official prior to the installation of high-intensity lighting. Fluorescent fixtures with good color-balanced bulbs generally are acceptable to all inspectors. Most fluorescent bulbs have a lighting efficiency 2 to 4 times greater than that of incandescent bulbs, and they last 6 to 12 times longer. Also, for equal light output the radiant heat produced by fluorescent bulbs is about 20 percent less than that generated by incandescent bulbs.

7. Investigate the replacement of obsolete air-cooled refrigeration units with water-cooled equipment. In some cases it is possible to reduce electrical energy requirements about 10 percent for the same output when water-cooled units with a water-cooling tower are used.

8. Reduce excessive energy consumption resulting from high head pressures with air-cooled condensing equipment by providing a good airflow around these units and by shading exposed units from excessive solar heat.

9. Replace small water heaters with one large-capacity quick-recovery heater. Less energy should be required to heat the same amount of water.

U. S. DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
SOUTHERN REGION
P. O. BOX 53326
NEW ORLEANS, LOUISIANA 70153

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

POSTAGE AND FEES PAID
U. S. DEPARTMENT OF
AGRICULTURE
AGR 101

U.S.MAIL

☆ U.S. GOVERNMENT PRINTING OFFICE: 1981— 771-039/408